



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

December 12, 2000

Fire Fighter Dies On Duty - Tennessee

SUMMARY

On August 20, 1998, a 58-year-old male Fire Fighter died while on light duty. He was placed on light duty by the Fire Department (FD) physician for multiple medical conditions. The death certificate, completed by the victim's personal physician, listed "acute myocardial infarction due to coronary artery disease" as the immediate cause of death and "diabetes mellitus Type II and renal failure" as other significant conditions.

The following recommendations address health and safety generally. It is unlikely, however, that any of these recommendations could have prevented the sudden cardiac arrest and subsequent death of this Fire Fighter. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH but represent published research or consensus votes of Technical Committees of the National Fire Protection Association (NFPA) or labor/management groups within the fire service. In addition, they are presented in a logical programmatic order and are not listed in a priority manner.

- *Fire fighters should have mandatory annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*
- *Exercise stress tests should be incorporated into the Fire Department's medical evaluation program.*

- *Develop a mechanism to ensure compliance with the mandatory wellness/fitness program.*
- *Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).*
- *Perform an autopsy on all on-duty fire fighters whose death may be cardiovascular-related.*

INTRODUCTION AND METHODS

On August 20, 1998, a 58-year-old male on-duty Fire Fighter died during his shift. On June 1, 2000, NIOSH contacted the affected Fire Department to initiate the investigation. On June 27, 2000, a Safety and Occupational Health Specialist and an Epidemiologist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Tennessee to conduct an on-site investigation of the incident.

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at:

<http://www.cdc.gov/niosh/firehome.html>

or call toll free 1-800-35-NIOSH

Fire Fighter Dies On Duty - Tennessee

During the investigation NIOSH personnel interviewed the following:

- Chief of Safety
- Fire Department attorney
- Fire Department personnel who responded to the victim's collapse
- Victim's wife
- Victim's private physician

During the site visit NIOSH personnel reviewed the following:

- Fire Department policies and operating guidelines
- Fire Department training records
- Fire Department annual report for 1998
- Fire Department physical examination protocols
- Death certificate
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident. On August 20, 1998, the victim reported for work at 0700 hours. He was on light duty for existing medical conditions and was working in the Air Mask Services Division. The morning was spent opening the facility and inspecting the self-contained breathing apparatus (SCBA) cylinder refilling equipment. At approximately 1100 hours, a Fire Fighter/Paramedic (FF-P) arrived at the Air Mask Division to refill SCBA cylinders. When he entered the facility, he noticed the victim sitting at a desk approximately 30 feet from the entry door. After approximately 15 minutes, the FF-P exited the refill room and noticed the victim's head down on the desk. The FF-P called the victim's name several times then shook him several times but received no response. Vital signs were checked which revealed no pulse, no respirations, and cyanotic lips. The FF-P repositioned the victim onto the floor and opened his airway. The FF-P telephoned Dispatch and notified them of a man down. He returned to the victim and started cardiopulmonary resuscitation (CPR)(chest compressions and mouth-to-mouth

ventilations). After performing CPR a short time, the FF-P telephoned Station 16, located next door, and notified crew members of the situation. Six fire fighters from Station 16 (four assigned to Engine 16 and two assigned to Truck 7) responded, taking over CPR (chest compressions and assisted ventilations via bag-valve-mask). A cardiac monitor was attached to the victim and revealed ventricular fibrillation (V.Fib.). Two initial attempts to perform defibrillation resulted in electromechanical disassociation (EMD). Throughout the incident, more than 15 defibrillation attempts were performed with no positive change in heart rhythm or patient status. The FF-P started an IV, administered advanced life support (ALS) medications, and performed intubation per protocol. EMS Unit 24 (two Paramedics) was dispatched at 1112 hours and arrived on the scene at 1117 hours. The victim was found to be unresponsive, pulseless, and not breathing. ALS treatment continued. The victim was loaded into Unit 24 which departed the scene at 1143 hours en route to the hospital. Unit 24 arrived at the hospital at 1148 hours. The victim was pronounced dead within 1 minute of arriving at the hospital.

Medical Findings. The death certificate, completed by the victim's personal physician, listed "acute myocardial infarction due to coronary artery disease" as the immediate cause of death and "diabetes mellitus Type II and renal failure" as other significant conditions. No autopsy was performed. Since the victim was not engaged in fire suppression activities, his blood was not tested for carbon monoxide poisoning (carboxyhemoglobin levels). The Fire Fighter had the following risk factors for coronary artery disease (CAD): hypertension (with last BP reading of 180/102) diagnosed in 1991, diabetes (requiring insulin) diagnosed in 1985, advancing age (greater than 45 years old), smoking (for approximately 25 years), and male gender. The victim was prescribed five anti-hypertensive medications and insulin to control the diabetes and took the

Fire Fighter Dies On Duty - Tennessee

medications as prescribed. The victim was diagnosed with diabetic nephropathy (kidney disease) requiring dialysis.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department consisted of 1,450 uniformed career personnel and served a population of 645,000 residents in a geographic area of 320 square miles. There are 53 fire stations. Fire fighters work the following schedule: 24 hours on duty and 24 hours off duty for three tours, then off duty for 4 days. While the victim worked on light duty, approximately 90 days, he worked Monday-Friday, 0700-1530.

In 1998, the Department responded to 71,029 engine runs, 29,751 truck runs, and 68,226 EMS runs. The victim did not make emergency runs while on light duty.

Training. The Fire Department requires all new fire fighters to pass a timed physical-agility test, a preemployment physical examination, a background check, and an oral interview prior to being hired. Once hired, the fire fighter must complete the 21-week fire fighter training course at the City Fire Academy to become certified as an NFPA-compliant Fire Fighter I/emergency medical technician (EMT) (within 1 year of appointment). Once recruit training is completed, the Fire Fighter is assigned to a shift. Subsequent training to the Fire Fighter II level is conducted on shift. All fire fighters are tested by personnel from the State of Tennessee to become certified as a Fire Fighter I or II. The State has no requirement for annual fire-fighter recertification; however, it does for hazardous materials (HAZMAT), EMT, confined space, and respiratory protection. The victim was certified as a Fire Fighter II, and he had 29 years of fire-fighting experience.

Preemployment/Preplacement Evaluations. The Department requires a preemployment/preplacement medical evaluation for all new hires, regardless of age. Components of this evaluation include the following:

- A complete medical and occupational history
- Height, weight, and vital signs
- Physical examination
- Blood tests: CBC, Sick cell screen, Comprehensive chemical screening profile, Syphilis screening, Hemoglobin electrophoresis
- Urine Tests: Urinalysis with microscopy, Urine drug screen, Urine alcohol screen
- Chest X-ray (PA and Lateral views) with interpretation and report
- Lumbosacral Spine X-ray (AP and Lateral views) with interpretation and report
- 12-lead resting electrocardiogram (ECG) with interpretation and report
- Whisper hearing test
- Audiometry with speech discrimination
- Spirometry
- Snellen vision screen
- Vision test: Visual acuity, Visual Field, Color vision
- Pregnancy test (if applicable)
- Pap Smear (if applicable)

These evaluations are performed by a contract physician hired by the City. Once the evaluations are complete, the physician makes a determination regarding medical clearance for fire-fighting duties and forwards this decision to the City's personnel director.

Periodic Evaluations. Voluntary periodic medical evaluations are offered by this Department to all fire fighters. Fire fighters under the age of 40 are eligible to be evaluated every other year, and fire fighters age 40 and over are eligible annually. According to the Department, most eligible Fire Fighters do not participate in the voluntary physical. Periodic medical

Fire Fighter Dies On Duty - Tennessee

evaluations are required for members of the HAZMAT team. The content of this evaluation includes the following:

- A complete medical and occupational history
- Height, weight, and vital signs
- Physical examination
- Blood tests: SAMC-25
- Urine Tests: Urinalysis, Urine toxicology screen
- Chest X-ray
- 12-lead resting electrocardiogram (ECG)
- Audiometry
- Pulmonary Function test
- Vision test: Color vision, refraction, depth perception

There were no Department medical evaluations for the victim. (He was hired prior to the preemployment evaluation requirement and never volunteered for the periodic medical evaluation). If an employee is injured at work or ill, the employee is evaluated and must be cleared for "return to work" by the fire fighter's private physician, and the results are reviewed by the City physician.

The Department has a mandatory fitness program. Each fire station Captain is responsible for fire-fighter attendance and maintaining an activity log, but participation varies from station to station. A physical fitness manual is available with program guidelines.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.¹ Risk factors for its development include increasing age, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.² The victim had four of these risk factors (male gender, diabetes, age over 45, and high blood pressure).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.³ However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.⁴ Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.⁵ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques.

To reduce the risk of heart attacks and sudden cardiac arrest among fire fighters, the National Fire Protection Association (NFPA) has developed guidelines entitled "Medical Requirements for Fire Fighters and Information for Fire Department Physicians," otherwise known as NFPA 1582.⁶ They recommend, in addition to screening for risk factors for CAD, an exercise stress EKG, otherwise known as an exercise stress test (EST). The EST is used to screen individuals for CAD. Unfortunately, it has problems with both false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for asymptomatic individuals (individuals without symptoms suggestive of angina).^{3,4} This has led other expert groups to **not** recommend EST for asymptomatic individuals without risk factors for CAD.^{5,7}

When these asymptomatic individuals **have** risk factors for CAD, however, recommendations vary by organization. The American College of Cardiology/American Heart Association (ACC/AHA) identifies four groups for EST although they note that the "usefulness/efficacy is less well established by evidence/opinion."⁵

- Group 1: Persons with multiple risk factors. They define five risk factors for CAD: hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (systolic greater than 140 mm Hg or diastolic greater than 90 mm Hg), smoking, diabetes, and family history

of premature CAD (cardiac event in first-degree relative less than 60 years old).

- Group 2: Men over the age of 40 and women over the age of 50 (especially if sedentary) who plan to start vigorous exercise.
- Group 3: Men over the age of 40 and women over the age of 50 who are at high risk for CAD due to other diseases (e.g., chronic renal failure).
- Group 4: Men over the age of 40 and women over the age of 50 who are involved in occupations in which impairment might impact public safety.

The U.S. Preventive Services Task Force (USPSTF) does not recommend EST for asymptomatic individuals, even those with risk factors for CAD; rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes).⁷ The USPSTF indicates that evidence is insufficient to recommend screening middle-age and older men or women in the general population; however, “screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety.”⁷

NFPA considers many of this Fire Fighter’s medical conditions as “Category B,” “a medical condition that, based on its severity or degree, could preclude a person from performing as a member in training or emergency operational environment by presenting a significant risk to the safety and health of the person or others.”⁶

Specifically, this includes CAD, diabetes mellitus requiring insulin, and kidney disease requiring dialysis. Thus, assigning this Fire Fighter to a light-duty job seemed entirely appropriate. Conducting periodic medical evaluations, as recommended by NFPA 1582, could have assisted the FD physician in determining whether this particular light-duty job was appropriate for this Fire Fighter.

RECOMMENDATIONS AND DISCUSSION

The following recommendations address health and safety generally. It is unlikely, however, that any of these recommendations could have prevented the sudden cardiac arrest and subsequent death of this Fire Fighter. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH but represent published research or consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. In addition, they are presented in a logical programmatic order and are not listed in a priority manner.

Recommendation #1: Fire Fighters should have mandatory annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and frequency of periodic medical evaluations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,⁶ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.⁸

NFPA recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity test.⁶ NFPA recommends a more thorough evaluation based on the age of the fire fighter. This more complete examination includes vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery according to the following schedule: (less than 30 years old, every 3 years; 30



Fatality Assessment and Control Evaluation Investigative Report #F2000-28

Fire Fighter Dies On Duty - Tennessee

to 39 years old, every 2 years; over 40 years old, every year).

Recommendation #2: Exercise stress tests should be incorporated into the Fire Department's medical evaluation program.

NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians, and the IAFF/IAFC wellness/fitness initiative both recommend at least biannual EST for fire fighters.^{6, 8} They recommend that these tests begin at age 35 for those with CAD risk factors and at age 40 for those without CAD risk factors. The EST could be conducted by the fire fighter's personal physician or the Department's contract physician. If the fire fighter's personal physician conducts the test, the results must be communicated to the City contract physician, who should be responsible for decisions regarding medical clearance for fire-fighting duties.

Recommendation #3: Develop a mechanism to ensure compliance with the mandatory wellness/fitness program.

Currently the Department requires fire fighter participation in a fitness program. This program could be enhanced by enforcing compliance and including components to improve aerobic capacity, flexibility, muscular strength, and muscular endurance. We suggest reviewing the IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative for applicable components.

Recommendation #4. Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).

OSHA's revised respiratory protection standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.⁹ These clearance evaluations are

required for private-industry employees and public employees in states operating OSHA-approved State plans. Tennessee is a State-plan State; therefore, public employees are required to comply with OSHA standards. A copy of the OSHA medical checklist has been provided to the Fire Department and should not involve a financial burden to the Fire Department beyond the preemployment or annual medical evaluation.

Recommendation #5: Autopsies should be performed on all on-duty fire fighters whose death may be cardiovascular-related.

In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.¹⁰ This publication hopes to provide "a more thorough documentation of the causes of firefighter deaths for three purposes:

- (1) to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
- (2) to help determine eligibility for death benefits under the Federal government's Public Safety Officer Benefits Program, as well as state and local programs; and
- (3) to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired."

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Fire Fighter Dies On Duty - Tennessee

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INVESTIGATOR INFORMATION

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